PATENT ABSTRACTS OF JAPAN

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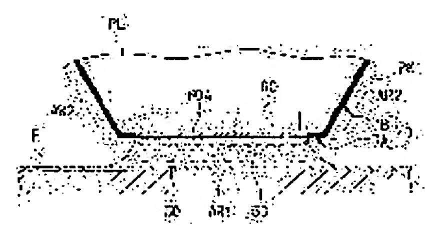
(54) EXPOSURE DEVICE, EXPOSURE METHOD, AND DEVICE MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an exposure device which transfers a pattern at a proper accuracy controlling an environmental change, even if a liquid flows out to an outside of a substrate, when an exposure processing is applied by a liquid immersion method.

SOLUTION: The exposure device exposes the substrate P by filling at least a part of space between a projection lens system PL and the substrate P with the liquid 50, and by projecting an image of the pattern on the substrate P through the projection lens system PL. An optical element 60 and a lens-barrel PK, which are parts to contact to the liquid 50 when the substrate P moves, are applied by a surface treatment to adjust an affinity to the liquid 50. A proper liquid immersion state is maintained as a bubble generation in the liquid between the projection lens system, the substrate is prevented and the liquid is kept between the projection lens system and the substrate at all times.



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CLAIMS

[Claim(s)]
[Claim 1]
It is the aligner which imprints the image of a pattern on a substrate through a liquid, and exposes a substrate. :
It has the projection optics which projects the image of said pattern on a substrate.;
The part in contact with said liquid of said projection optics is an aligner by which surface treatment is carried out in order to adjust compatibility with a liquid.
[Claim 2]
Exposure of said substrate is an aligner according to claim 1 performed while moving said substrate to a scanning direction.
[Claim 3]
Said surface treatment is an aligner according to claim 1 or 2 performed according to the polarity of said liquid.
[Claim 4]
Said liquid is an aligner according to claim 3 with which it is water and said surface treatment is carried out to the part in contact with said liquid by forming a thin film by the matter of the polar large molecular structure.
[Claim 5]
Said liquid is an aligner according to claim 3 with which it is a fluorine system liquid and said surface treatment is carried out to the part in contact with said liquid by forming a thin film by the matter of the polar small molecular structure.
[Claim 6]
For a part of [each] said optical element front face and front face of said attachment component, the part in contact with the liquid of said projection optics is an aligner of claim 1-5 given in any 1 term by which surface treatment is carried out so that the compatibility over said liquid may become high including a part of front face of the optical element at the tip of said projection optics, and front face [at least] of the attachment component holding this optical element. [at least]
[Claim 7]
The part of the parts in contact with the liquid of said projection optics which exposure light passes at least is an aligner according to claim 1 by which surface treatment is carried out so that compatibility with said liquid may become high.
[Claim 8]
It is the aligner which imprints the image of a pattern on a substrate through a liquid, and exposes a substrate. :
It has the projection optics which projects the image of said pattern on a substrate.;
Said projection optics has the 1st surface field including the optical element front face at the tip, and the 2nd surface field around the 1st surface field,
An aligner with the compatibility higher than the compatibility over the liquid of the 2nd surface field over the liquid of the 1st surface field.
[Claim 9]
The aligner according to claim 8 with which said liquid is held in said 1st surface field in the compatibility over said liquid of said 1st surface field according to it being higher than the compatibility over said liquid of said 2nd surface field.
[Claim 10]

It is conditional expression, using [the rate of said liquid flow / thickness / of said liquid between said projection optics and said substrates / between d, and said projection optics and said substrate] coefficient of viscosity of rho and said liquid as mu for the consistency of v and said liquid.
(V-d-rho) /mu<=2000
******** -- the aligner of claim 1-9 characterized by things given in any 1 term.
[Claim 11]
It is the aligner of claim 1-9 which equips at least the part between said projection optics and said substrates with the immersion equipment which pours said liquid, and is characterized by said liquid flowing as a laminar flow given in any 1 term.
[Claim 12]
It is the aligner which illuminates a pattern with an exposure beam, imprints the image of a pattern on a substrate through a liquid, and exposes a substrate. :
Projection optics which projects the image of said pattern on a substrate;
It has immersion equipment which fills at least the part between said projection optics and substrates with a liquid.;
It is conditional expression, using [the rate of the liquid flow / thickness / of a liquid / between d, projection optics, and a substrate] coefficient of viscosity of rho and a liquid as mu for the consistency of v and a liquid.
(V-d-rho) /mu<=2000
The aligner by which ** satisfactory is carried out.
[Claim 13]
The amount of supply of said liquid have the feeder which supplies said liquid between said projection optics and said substrates, and the recovery system which collects the liquids between said projection optics and said substrates, and according to said feeder, and the amount of recovery of said liquid by said recovery system are an aligner according to claim 12 determined that it will fill said conditional expression.
[Claim 14]
It is the aligner according to claim 13 which scan exposure is carried out while said substrate moves to a scanning direction, and is determined that the passing speed of said substrate under said scan exposure will fill said conditional expression.
[Claim 15]
It is the aligner according to claim 12 which scan exposure is carried out while said substrate moves to a scanning direction, and is determined that the passing speed of said substrate under said scan exposure will fill said conditional expression.
[Claim 16]
The direction where said liquid flows is an aligner [parallel to said scanning direction] according to claim 14 or 15.
[Claim 17]
It is an aligner given in any 1 term of claims 12-16 whose thickness d of said liquid it is filled with said liquid between said projection optics and said substrates, and is spacing of said projection optics and said substrate.
[Claim 18]
It is the aligner of claim 12-16 whose thickness d of said liquid cover glass is laid on said substrate in the case of exposure, and is spacing of said projection optics and said cover glass given in any 1 term.
[Claim 19]
It is the aligner which illuminates the pattern of a mask with an exposure beam, imprints the image of a pattern on a substrate through a liquid, and exposes a substrate. :
Projection optics which projects the image of said pattern on a substrate;
It has the immersion equipment for filling at least the part between said projection optics and substrates with a liquid, and;,
The aligner with which said liquid serves as a laminar flow, and flows to the scanning direction of a substrate, and parallel.
[Claim 20]
The aligner according to claim 19 with which the passing speed to the scanning direction of said substrate under exposure of said substrate is determined that said liquid will flow as a laminar flow.
[Claim 21]
Said immersion equipment is an aligner according to claim 20 which has the feeder which supplies said

liquid, and the recovery system which collects said liquids.
[Claim 22]
Furthermore, the aligner according to claim 21 equipped with the control unit which controls the amount of supply of said liquid by the feeder, and the amount of recovery of said liquid by said recovery system so that said liquid may flow as a laminar flow.
[Claim 23]
An aligner is an aligner according to claim 19 which has the feeder to which said immersion equipment supplies said liquid, and the recovery system which collects said liquids, and is equipped with the control unit which controls the amount of supply of said liquid by the feeder, and the amount of recovery of said liquid by said recovery system so that said liquid may flow as a laminar flow further.
[Claim 24]
Said liquid is the aligner of claim 12-23 characterized by being water given in any 1 term.
[Claim 25]
Said liquid is the aligner of claim 12-23 characterized by being a fluorine system liquid given in any 1 term.
[Claim 26]
The aligner according to claim 19 with which it has the feeder to which said immersion equipment supplies said liquid, and the recovery system which collects said liquids, and a feeder has the nozzle with which the slit or the porous body was prepared in the nozzle.
[Claim 27]
It is the aligner which illuminates a pattern with an exposure beam, imprints the image of a pattern on a substrate through a liquid, and exposes a substrate. :
Projection optics which projects the image of said pattern on a substrate;
Immersion equipment which supplies a liquid only on a substrate;
It has the control unit which controls said immersion equipment.;
This control unit is an aligner which controls immersion equipment so that supply of a liquid is suspended during exposure of a substrate.
[Claim 28]
The thickness of the liquid supplied on said substrate is an aligner according to claim 27 which is thinner than the working distance of said projection optics, and is held on said substrate with surface tension.
[Claim 29]
The device manufacture approach characterized by manufacturing a device using the aligner of claim 1-28 given in any 1 term.
[Claim 30]
In the exposure approach which projects the image of the pattern by projection optics on a substrate, and exposes a substrate :
Before exposure, in order to adjust compatibility with a liquid, surface treatment of the front face of a substrate is carried out.;
At least the part between projection optics and a substrate is filled with a liquid.;
The exposure approach including projecting the image of a pattern on a substrate through a liquid.
[Claim 31]
Exposure of said substrate is the exposure approach according to claim 30 performed while moving said substrate to a scanning direction.
[Claim 32]
Said surface treatment is the exposure approach according to claim 30 or 31 performed according to the polarity of said liquid.
[Claim 33]
Said liquid is the exposure approach according to claim 32 which is water and forms a thin film in the part in contact with said liquid by the matter of the polar large molecular structure.
[Claim 34]
Said liquid is the exposure approach according to claim 32 which is a fluorine system liquid and forms a thin film in the part in contact with said liquid by the matter of the polar small molecular structure.
[Claim 35]
The device manufacture approach characterized by manufacturing a device using the exposure approach of a publication in any 1 term of claims 30-34.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
This invention relates to the device manufacture approach at the aligner exposed by the pattern image which projected at least the part between projection optics and a substrate according to projection optics in the condition of having filled with the liquid and the exposure approach, and a list.
[Background of the Invention]
[0002]
A semiconductor device and a liquid crystal display device are manufactured by the technique of the so-called photolithography which imprints the pattern formed on the mask on a photosensitive substrate. The aligner used at this photolithography process has the mask stage which supports a mask, and the substrate stage which supports a substrate, and it imprints the pattern of a mask to a substrate through projection optics, moving serially on a mask stage and a substrate stage. Since it corresponds to much more high integration of a device pattern in recent years, the further high resolution-ization of projection optics is desired. The resolution of projection optics becomes so high that the numerical aperture of projection optics is so large that the exposure wavelength to be used becomes short. Therefore, exposure wavelength used with an aligner is short-wavelength-ized every year, and the numerical aperture of projection optics is also increasing. And although the exposure wavelength of the current mainstream is 248nm of KrF excimer laser, no less than 193nm of the ArF excimer laser of short wavelength is being put further in practical use. Moreover, in case it exposes, the depth of focus (DOF) as well as resolution becomes important. Resolution R and the depth of focus delta are expressed with the following formulas, respectively.
R=k1 and lambda/NA -- (1)
delta=**k2 and lambda/NA 2 -- (2)
Here, the numerical aperture of projection optics, and k1 and k2 is [lambda of exposure wavelength and NA] process multipliers. (1) In order to raise resolution R, when exposure wavelength lambda is shortened and numerical aperture NA is enlarged from a formula and (2) types, it turns out that the depth of focus delta becomes narrow.
[0003]
When the depth of focus delta becomes narrow too much, it becomes difficult to make a substrate front face agree to the image surface of projection optics, and there is a possibility that the focal margins at the time of exposure actuation may run short. Then, the immersion method which considers as the approach of shortening exposure wavelength substantially and making the depth of focus large, for example, is indicated by the international public presentation/[99th] No. 49504 official report is proposed. This immersion method expands the depth of focus by about n times while it improves resolution using filling between the inferior surface of tongue of projection optics, and substrate front faces with liquids, such as water and an organic solvent, and the wavelength of the exposure light in the inside of a liquid being set to 1/n in air (n being usually 1.2 to about 1.6 at the refractive index of a liquid).
[Patent reference 1] International public presentation/[99th] No. 49504 pamphlet
[Description of the Invention]
[Problem(s) to be Solved by the Invention]
[0004]
By the way, when exposing moving a substrate to projection optics between the case where a liquid is exposed with a sink, and projection optics and a substrate, between projection optics and a substrate where a liquid is filled, a liquid may exfoliate to projection optics or a substrate and un-arranging [that the pattern

image imprinted by the substrate deteriorates] arises. Or also when a liquid is exposed with a sink between projection optics and a substrate and a turbulent flow arises in the liquid flow, a pattern image deteriorates.
[0005]
This invention is made in view of such a situation, a liquid is filled between projection optics and a substrate, and in case exposure processing is carried out, it aims at providing with the device manufacture approach the aligner which arranges in the condition of a request of a liquid and can imprint a pattern with a sufficient precision and the exposure approach, and a list.
[Means for Solving the Problem]
[0006]
In order to solve the above-mentioned technical problem, this invention has adopted the configuration of the following matched with drawing 1 shown in the gestalt of operation - drawing 10 .
[0007]
If the 1st mode of this invention is followed, it will be the aligner which imprints the image of a pattern on a substrate (P) through a liquid (50), and exposes a substrate. :
It has the projection optics (PL) which projects the image of said pattern on a substrate,
In order that the part (60 PK) in contact with said liquid (50) of said projection optics (PL) may adjust compatibility with a liquid (50), the aligner (EX) by which surface treatment is carried out is offered.
[0008]
In the aligner of this invention, since surface treatment for adjusting compatibility with a liquid to the part (suitably henceforth a "liquid contact part") in contact with the liquid of liquid projection optics is performed, a liquid is maintained in the state of a request between projection optics and a substrate. For example, said part and liquid which contact exfoliate [compatibility with the liquid of a liquid contact part] a low **** case, or the phenomenon which has a bad influence on immersion exposure of air bubbles being generated arises. On the other hand, when compatibility with the liquid of a liquid contact part is too high, un-arranging [of a liquid being superfluously damp, spreading to said part which contacts, and flowing out of between projection optics and substrates] may arise. On the other hand, in the aligner of this invention, since compatibility with the liquid of the liquid contact part of projection optics is adjusted, even if it is the scanning aligner with which a substrate is moved by the migration stage not only the one-shot exposure to which the substrate is at a standstill to exposure light during exposure but during exposure, an immersion condition is certainly maintained between a substrate and projection optics.
[0009]
If the 2nd mode of this invention is followed, it will be the aligner which imprints the image of a pattern on a substrate (P) through a liquid (50), and exposes a substrate. :
It has the projection optics (PL) which projects the image of said pattern on a substrate.;
It has the 1st surface field (AR1) where said projection optics (PL) includes the optical element (60) front face at the tip, and the 2nd surface field (AR2) around the 1st surface field (AR1), and an aligner (EX) with the compatibility higher than the compatibility over the liquid (50) of the 2nd surface field (AR2) over the liquid (50) of the 1st surface field (AR1) is offered.
[0010]
While according to this invention a liquid is stabilized on the optical path of exposure light by the 1st surface field and being arranged by making compatibility over the liquid of the 1st surface field containing the optical element at the tip of projection optics higher than the 2nd surface field of the circumference of it, a liquid is around damp with the 2nd surface field, and it does not spread, and does not flow out outside. Therefore, even if it is the scanning exposure by which a substrate is moved to exposure light not only the one-shot exposure to which the substrate is at a standstill to exposure light during exposure but during exposure, a liquid can be stabilized and arranged on the optical path of exposure light.
[0011]
If the 3rd mode of this invention is followed, a pattern will be illuminated with an exposure beam (EL). A liquid (50) is minded for the image of a pattern. It has the projection optics (PL) and; projection optics (PL) which are the aligner which imprints on a substrate (P) and exposes a substrate, and project the image of the :aforementioned pattern on a substrate, and immersion equipment (1 2) which fills at least the part between substrates (P) with a liquid (50). The thickness of; liquid (50) d, It is conditional expression, using [the rate of the flow of the liquid (50) between projection optics (PL) and a substrate (P)] coefficient of viscosity of rho and a liquid (50) as mu for the consistency of v and a liquid (50). (v-d-rho) /mu<=2000 The aligner (EX) satisfied is offered.
[0012]

According to this invention, a turbulent flow does not arise into a liquid by setting up the conditions on which a liquid is maintained by at least the part between projection optics (PL) and a substrate (P) so that the above-mentioned conditional expression may be satisfied. Therefore, it can stop un-arranging [that the pattern image which originates in the turbulent flow of a liquid and is projected on a substrate deteriorates].
[0013]
If the 4th mode of this invention is followed, the pattern of a mask (M) will be illuminated with an exposure beam (EL). A liquid (50) is minded for the image of a pattern. It imprints on a substrate (P). A substrate It is the aligner to expose. The image of the :aforementioned pattern It has immersion equipment (1 2) for filling with a liquid at least the part between the projection optics (PL) and; projection optics (PL) which are projected on a substrate, and a substrate (P), and the aligner (EX) with which; liquid (50) becomes a laminar flow, and flows to the scanning direction of a substrate (P) and parallel is offered.
[0014]
Since a liquid serves as a laminar flow and flows to the scanning direction of a substrate, and parallel during exposure by controlling an immersion condition by various approaches according to this invention, degradation of the pattern image projected on a substrate can be prevented. Moreover, the substrate stage holding the projection optics, wafer, or wafer which touches a liquid etc. is not made to generate an unnecessary vibration. For example, liquid flow can be laminar-flow-ized by adjusting the rate, in controlling the amount of liquid supplies (recovery) of immersion equipment, adjusting the structure of the liquid supply nozzle of immersion equipment or moving a substrate at the time of exposure.
[0015]
If the 5th mode of this invention is followed, a pattern will be illuminated with an exposure beam (EL). A liquid (50) is minded for the image of a pattern. It imprints on a substrate (P). It has the control unit (CONT) which is an aligner which exposes a substrate and controls the immersion equipment (1 2) which supplies a liquid (50) only on :the projection optics (PL) which projects the image of said pattern on a substrate and; substrate (P), and; immersion equipment (1 2).; this control unit (CONT) The aligner (EX) which controls immersion equipment (1 2) so that supply of a liquid (50) is suspended during exposure of a substrate (P) is offered.
[0016]
According to this invention, by being controlled so that immersion equipment does not supply a liquid during exposure of a substrate, degradation of the pattern which does not damage the sensitization agent applied on the substrate and is formed on a substrate can be prevented, and it is stabilized and the physical relationship of projection optics and a substrate can be maintained in the desired condition.
[0017]
In the exposure approach which will project the image of the pattern by projection optics (PL) on a substrate (P), and will expose a substrate (P) if the 6th mode of this invention is followed before :exposure At least the part between carrying out surface treatment of the front face of a substrate (P), in order to adjust compatibility with a liquid (50),; projection optics (PL), and a substrate (P) is filled with a liquid (50).; The exposure approach including projecting the image of a pattern on a substrate (P) through a liquid (50), and exposing a substrate (P) is offered.
[0018]
According to this invention, before immersion exposure is performed, a liquid is maintainable in the suitable condition for immersion exposure on a substrate performing surface treatment according to compatibility with a liquid to the front face of a substrate. For example, when compatibility with a liquid is too low, a liquid exfoliates or un-arranging [of air bubbles being generated to the front face of a substrate] arises. On the other hand, when compatibility with a liquid is too high, un-arranging -- on a substrate, a liquid is superfluously damp and spreads -- may arise. On the other hand, like the exposure approach of this invention, by performing suitable processing for a substrate front face, it can hold in the condition of a request of a liquid on a substrate, and recovery and removal of the liquid on a substrate can be appropriately performed in consideration of compatibility with a liquid.
[Effect of the Invention]
[0019]
Since according to this invention exfoliation of a liquid, generating of air bubbles, or generating of a turbulent flow is suppressed between projection optics and a substrate and a liquid can be maintained in the state of a request in immersion exposure, a pattern imprint can be correctly performed under the large depth of focus. Therefore, this invention is very useful to the exposure which uses sources of short wave Nagamitsu, such as ArF, and the high integration device which has the desired engine performance can be

manufactured.
[Best Mode of Carrying Out the Invention]
[0020]
Although explained hereafter, referring to a drawing about the aligner and the device manufacture approach of this invention, this invention is not limited to this. Drawing 1 is the outline block diagram showing 1 operation gestalt of the aligner of this invention.
[0021]
The mask stage MST where Aligner EX supports Mask M in drawing 1 The illumination-light study system IL which illuminates the mask M currently supported by the substrate stage PST which supports Substrate P, and the mask stage MST with the exposure light EL It has the control unit CONT which carries out generalization control of the actuation of the projection optics PL which carries out projection exposure of the image of the pattern of the mask M illuminated with the exposure light EL at the substrate P currently supported by the substrate stage PST, and the whole aligner EX.
[0022]
Here, with this operation gestalt, carrying out a synchronized drive for being suitable (hard flow), as an aligner EX, the case where the scanning aligner (the so-called scanning stepper) which exposes a mutually different pattern [in / for Mask M and Substrate P / a scanning direction] formed in Mask M to Substrate P is used is made into an example, and it explains. Let [the direction which is in agreement with the optical axis AX of projection optics PL] a direction (non-scanning direction) perpendicular to X shaft orientations, Z shaft orientations, and Y shaft orientations be Y shaft orientations for the direction of a synchronized drive of Mask M and Substrate P (scanning direction) in the following explanation in a flat surface perpendicular to Z shaft orientations and Z shaft orientations. Moreover, let the directions of the circumference of the X-axis, a Y-axis, and the Z-axis be thetaX, thetaY, and theta Z direction, respectively. In addition, a "substrate" here contains the reticle the "mask" had the device pattern by which contraction projection is carried out formed on a substrate including what applied the resist on the semi-conductor wafer.
[0023]
The illumination-light study system IL illuminates the mask M currently supported by the mask stage MST with the exposure light EL, and has the adjustable field diaphragm which sets up the lighting field on the condensing lens which condenses the exposure light EL from an optical integrator and an optical integrator which equalizes the illuminance of the flux of light injected from the light source for exposure, and the light source for exposure, a relay lens system, and the mask M by the exposure light EL in the shape of a slit. The predetermined lighting field on Mask M is illuminated by the illumination-light study system IL with the exposure light EL of uniform illumination distribution. As an exposure light EL injected from the illumination-light study system IL, vacuum-ultraviolet light (VUV light), such as far-ultraviolet light (DUV light), such as the bright line (g line, h line, i line) of an ultraviolet region, KrF excimer laser light (wavelength of 248nm), etc. which are injected, for example from a mercury lamp, and ArF excimer laser light (wavelength of 193nm), F2 laser beam (wavelength of 157nm), etc. is used. ArF excimer laser light is used in this operation gestalt.
[0024]
that to which a mask stage MST supports Mask M -- it is -- the inside of a flat surface perpendicular to the optical axis AX of projection optics PL, i.e., XY flat surface, -- two-dimensional -- minute to movable and theta Z direction -- it is pivotable. A mask stage MST is driven with the mask stage driving gears MSTD, such as a linear motor. The mask stage driving gear MSTD is controlled by the control unit CONT. The location of the two-dimensional direction of the mask M on a mask stage MST and an angle of rotation are measured on real time by the laser interferometer, and a measurement result is outputted to a control unit CONT. A control device CONT positions the mask M currently supported by the mask stage MST by driving the mask stage driving gear MSTD based on the measurement result of a laser interferometer.
[0025]
Projection optics PL carries out projection exposure of the pattern of Mask M for the predetermined projection scale factor beta at Substrate P, it consists of two or more optical elements (lens), and these optical elements are supported by the lens-barrel PK formed by the metal member (SUS403), for example, stainless steel. In this operation gestalt, the projection scale factor beta of projection optics PL is the contraction system of 1/4 or 1/5. In addition, any of unit systems and an expansion system are sufficient as projection optics PL. Moreover, the plane-parallel plate (optical element) 60 formed from glass members, such as a quartz and a calcium fluoride (fluorite), is formed in the point 7 by the side of the substrate P of the projection optics PL of this operation gestalt. This optical element 60 is formed possible [attachment

and detachment (exchange)] to Lens-barrel PK. The point 7 of projection optics PL is constituted by the optical element 60 and a part of lens-barrel (attachment component) PK holding this.
[0026]
The substrate stage PST is equipped with Z stage 51 which holds Substrate P through a substrate holder, X-Y stage 52 which supports Z stage 51, and the base 53 which supports X-Y stage 52 in support of Substrate P. The substrate stage PST is driven with the substrate stage driving gears PSTD, such as a linear motor. The substrate stage driving gear PSTD is controlled by the control unit CONT. By driving Z stage 51, the location in the location (focal location) in Z shaft orientations of the substrate P currently held at Z stage 51 and thetaX, and the direction of thetaY is controlled. Moreover, the location (it is [the image surface of projection optics PL and] the location of an parallel direction substantially) in the XY direction of Substrate P is controlled by driving X-Y stage 52. That is, Z stage 51 controls the focal location and tilt angle of Substrate P, and doubles the front face of Substrate P with the image surface of projection optics PL by the automatic focus method and the auto leveling method, and X-Y stage 52 performs positioning in X shaft orientations and Y shaft orientations of Substrate P. In addition, it cannot be overemphasized that a Z stage and an X-Y stage may be prepared in one.
[0027]
On the substrate stage PST (Z stage 51), the migration mirror 54 which moves to projection optics PL with the substrate stage PST is formed. Moreover, the laser interferometer 55 is formed in the location which counters the migration mirror 54. The location of the two-dimensional direction of the substrate P on the substrate stage PST and an angle of rotation are measured on real time by the laser interferometer 55, and a measurement result is outputted to a control unit CONT. A control device CONT positions the substrate P currently supported by the substrate stage PST by driving the substrate stage driving gear PSTD based on the measurement result of a laser interferometer 55.
[0028]
With this operation gestalt, while shortening exposure wavelength substantially and improving resolution, in order to make the depth of focus large substantially, an immersion method is applied. Therefore, while imprinting the image of the pattern of Mask M on Substrate P at least, the predetermined liquid 50 is filled between the front face of Substrate P, and the point 7 of projection optics PL. As mentioned above, a part of optical element 60 and lens-barrel PK are arranged at the point 7 of projection optics PL, and a liquid 50 contacts an optical element (glass member) 60 and Lens-barrel (metal member) PK. Pure water is used for a liquid 50 in this operation gestalt. Pure water can penetrate this exposure light EL, when not only ArF excimer laser light but exposure light EL is made into far-ultraviolet light (DUV light), such as the bright line (g line, h line, i line) of an ultraviolet region, KrF excimer laser light (wavelength of 248nm), etc. which are injected from a mercury lamp.
[0029]
Aligner EX is equipped with the point 7 of projection optics PL, the liquid feeder (immersion equipment, feeder) 1 which supplies the predetermined liquid 50 to the space 56 between Substrates P, and the liquid recovery system (immersion equipment, recovery system) 2 which collects the liquids 50 of space 56. The liquid feeder 1 pours a liquid 50 to the scanning direction of Substrate P, and parallel, and equips at least the part between projection optics PL and Substrate P with a tank, a booster pump, etc. which hold a liquid 50. The end section of a supply pipe 3 is connected to the liquid feeder 1, and the supply nozzle 4 is connected to the other end of a supply pipe 3. The liquid feeder 1 supplies a liquid 50 to space 56 through a supply pipe 3 and the supply nozzle 4.
[0030]
The liquid recovery system 2 is equipped with the tank which holds a suction pump and the collected liquid 50. The end section of the recovery tubing 6 is connected to the liquid recovery system 2, and the recovery nozzle 5 is connected to the other end of the recovery tubing 6. The liquid recovery system 2 collects the liquids 50 of space 56 through the recovery nozzle 5 and the recovery tubing 6. In case a liquid 50 is filled to space 56, a control unit CONT drives the liquid recovery system 2, and collects the liquids 50 of the specified quantity from space 56 per unit time amount through the recovery nozzle 5 and the recovery tubing 6 while it drives the liquid feeder 1 and supplies the liquid 50 of the specified quantity per unit time amount to space 56 through a supply pipe 3 and the supply nozzle 4. Thereby, a liquid 50 is arranged in the apical surface 7 of projection optics PL, and the space 56 between Substrates P.
[0031]
At the time of scan exposure, some pattern images of Mask M are projected on the projection field of the rectangle [directly under] of apical surface 60A, and Substrate P moves in the direction of +X (or the

direction of -X) by rate beta-V (beta is a projection scale factor) through X-Y stage 52 to projection optics PL synchronizing with Mask M moving in the direction of -X (or the direction of +X) at a rate V. And after exposure ending to one shot field, the next shot field moves to a scan starting position by stepping of Substrate P, and exposure processing to each shot field is hereafter performed one by one by step - and - scanning method. With this operation gestalt, it is set up so that a liquid 50 may be poured in the same direction as the migration direction of a substrate to the migration direction of Substrate P, and parallel.
[0032]
Drawing 2 is drawing showing the physical relationship of the point 7 of projection optics PL, the supply nozzle 4 (4A-4C) which supplies a liquid 50 to X shaft orientations, and the recovery nozzle 5 (5A, 5B) which collects liquids 50. In drawing 2 , the configuration of a point 7 (apical surface 60A of an optical element 60) is the shape of a long and slender rectangle at Y shaft orientations, three supply nozzles 4A-4C are arranged at the direction side of +X, and two recovery nozzles 5A and 5B are arranged at the direction side of -X so that X shaft orientations may pinch the point 7 of projection optics PL. And the supply nozzles 4A-4C are connected to the liquid feeder 1 through a supply pipe 3, and the recovery nozzles 5A and 5B are connected to the liquid recovery system 2 through the recovery tubing 4. Moreover, the supply nozzles 8A-8C and the recovery nozzles 9A and 9B are arranged at the arrangement which rotated the supply nozzles 4A-4C and the recovery nozzles 5A and 5B 180 degrees of abbreviation to the core of a point 7. The supply nozzles 4A-4C and the recovery nozzles 9A and 9B are arranged by turns by Y shaft orientations, the supply nozzles 8A-8C and the recovery nozzles 5A and 5B are arranged by turns by Y shaft orientations, the supply nozzles 8A-8C are connected to the liquid feeder 1 through a supply pipe 10, and the recovery nozzles 9A and 9B are connected to the liquid recovery system 2 through the recovery tubing 11. It is necessary to perform supply of the liquid from a nozzle so that a gas part may not arise between projection optics PL and Substrate P.
[0033]
Moreover, as shown in drawing 3 , on both sides of a point 7, the supply nozzles 31 and 32 and the recovery nozzles 33 and 34 can also be formed in each of Y shaft-orientations both sides. By this supply nozzle and the recovery nozzle, a liquid 50 can be stabilized and supplied between projection optics PL and Substrate P at the time of migration to the non-scanning direction (Y shaft orientations) of the substrate P at the time of carrying out step migration.
[0034]
In addition, especially the configuration of the nozzle mentioned above is not limited and may be made to perform supply or recovery of a liquid 50 with two pairs of nozzles about the long side of a point 7. In addition, in this case, in order to enable it to perform supply and recovery of a liquid 50 also from the which direction of the direction of +X, or the direction of -X, it may compare with a supply nozzle and a recovery nozzle up and down, and you may arrange.
[0035]
Drawing 4 is an about seven point [of projection optics PL] enlarged drawing. In drawing 4 , surface treatment according to compatibility with a liquid 50 is performed to the point 7 of projection optics PL. A point 7 is a part in contact with a liquid 50, when moving Substrate P to a scanning direction (X shaft orientations), in order to carry out scan exposure, and it contains a part of side-face 7B of the lens-barrel PK linked to inferior-surface-of-tongue 7A and this inferior-surface-of-tongue 7A of the projection optics PL including a part of inferior-surface-of-tongue 60A of an optical element 60, and lens-barrel PK inferior surface of tongue. In this operation gestalt, since a liquid 50 is water, surface treatment according to compatibility with water is performed to the point 7.
[0036]
In the point 7 of projection optics PL, surface treatment from which the 2nd surface field AR 2 which are the 1st surface field AR 1 including some fields of the inferior surface of tongue of surface (inferior surface of tongue) 60A of an optical element 60 and Lens-barrel PK and this 1st surface field AR1 circumference, and includes the remaining fields of the inferior surface of tongue of Lens-barrel PK and the side face of Lens-barrel PK differs mutually is performed. Surface treatment is performed to each of the 1st and 2nd surface fields AR1 and AR2 so that the compatibility over the liquid(water) 50 of the 1st surface field AR 1 may specifically become higher than the compatibility over the liquid(water) 50 of the 2nd surface field AR 2. Here, lyophilic-ized processing (hydrophilization processing) which gives lyophilic to the 1st surface field AR 1 containing an optical element 60, and liquid repelling processing (water-repellent treatment) which gives liquid repellance to the 2nd surface field AR 2 are performed. Lyophilic-ized processing is processing which makes compatibility over a liquid high, and liquid repelling processing is processing

which makes compatibility over a liquid low.
[0037]
Surface treatment is performed according to the polarity of a liquid 50. In this operation gestalt, since a liquid 50 is polar large water, it is forming a thin film by matter of the polar large molecular structure, such as alcohol, as hydrophilization processing to the 1st surface field AR 1 containing an optical element 60, and gives a hydrophilic property to this 1st surface field AR 1. Or since many strong polar O molecules gather in a front face by performing O2 plasma treatment which carries out plasma treatment, using oxygen (O2) as raw gas as opposed to inferior-surface-of-tongue 60A of the optical element 60 of the 1st surface field AR 1, and Lens-barrel PK, a hydrophilic property can be given. Thus, when using water as a liquid 50, the processing which arranges on a front face what had the polar large molecular structures, such as an OH radical, in the 1st surface field AR 1 is desirable. moreover, since the 1st surface field AR 1 contains the optical element 60 which is a glass member, and the lens-barrel PK which is a metal member, when carrying out hydrophilization processing, it can perform different surface treatment, such as it being alike, respectively and forming a thin film by different matter of a glass member and a metal member. Of course, the same surface treatment may be performed to each of the glass member of the 1st surface field AR 1, and a metal member. Moreover, when forming a thin film, technique, such as spreading and vacuum evaporationo, can be used.
[0038]
On the other hand, water-repellent treatment is given to the 2nd surface field AR 2 including a lens-barrel PK front face. Water repellence is given to this 2nd surface field AR 2 by forming a thin film by the matter containing a fluorine of the polar small molecular structure as water-repellent treatment to the 2nd surface field AR 2. Or water repellence can be given by performing CF4 plasma treatment which carries out plasma treatment, using carbon tetrafluoride (CF4) as raw gas. When forming a thin film to the 2nd surface field AR 2, technique, such as spreading and vacuum evaporationo, can be used.
[0039]
Moreover, with this operation gestalt, surface treatment is performed also according to the compatibility with a liquid 50 or the front face of Substrate P. Here, hydrophilization processing is performed to the front face of Substrate P. As hydrophilization processing to Substrate P, it gives lyophilic to the front face of Substrate P by forming a thin film by matter of the molecular structure with polarities large, for example, such as alcohol, which was mentioned above. In addition, when alcohol etc. is applied and surface preparation of the front face of Substrate P is carried out, before conveying a substrate to following last process, for example, a developer/coating machine, of spreading of sensitive material, it is desirable [it is after exposure, and] to establish the washing process for washing a paint film.
[0040]
And by making compatibility over the liquid 50 of the 1st surface field AR 1 higher than the compatibility over the liquid 50 of the 2nd surface field AR 2, in the 1st surface field AR 1, a liquid 50 is stabilized and is held.
[0041]
Here, the thin film for surface treatment is formed with an undissolved ingredient to a liquid 50. Moreover, since the thin film formed in an optical element 60 is what is arranged on the optical path of the exposure light EL, it is formed with the ingredient which has permeability to the exposure light EL, and is set as extent to which the thickness can also penetrate the exposure light EL.
[0042]
Next, the operation at the time of exposing the pattern of Mask M to Substrate P using the aligner EX mentioned above is explained.
[0043]
If Substrate P is loaded to the substrate stage PST while Mask M is loaded to a mask stage MST, a control unit CONT will drive the liquid feeder 1, and will start the liquid supply actuation to space 56. The liquid feeder 1 supplies a liquid 50 along the migration direction of Substrate P to space 56. For example, when moving Substrate P to the scanning direction (the direction of -X) shown by the arrow head Xa (refer to drawing 2) and performing scan exposure, supply and recovery of a liquid 50 are performed by the liquid feeder 1 and the liquid recovery system 2 using a supply pipe 3, the supply nozzles 4A-4C, the recovery tubing 4, and the recovery nozzles 5A and 5B. namely, in case Substrate P moves in the direction of -X While a liquid 50 is supplied between projection optics PL and Substrate P from the liquid feeder 1 through a supply pipe 3 and the supply nozzle 4 (4A-4C) Liquids 50 are collected by the liquid recovery system 2 through the recovery nozzle 5 (5A, 5B) and the recovery tubing 6, and a liquid 50 flows in the direction of -

X so that between a lens 60 and Substrates P may be filled. When moving Substrate P to the scanning direction (the direction of +X) shown by the arrow head Xb on the other hand and performing scan exposure, supply and recovery of a liquid 50 are performed by the liquid feeder 1 and the liquid recovery system 2 using a supply pipe 10, the supply nozzles 8A-8C, the recovery tubing 11, and the recovery nozzles 9A and 9B. namely, in case Substrate P moves in the direction of +X While a liquid 50 is supplied between projection optics PL and Substrate P from the liquid feeder 1 through a supply pipe 10 and the supply nozzle 8 (8A-8C) Liquids 50 are collected by the liquid recovery system 2 through the recovery nozzle 9 (9A, 9B) and the recovery tubing 11, and a liquid 50 flows in the direction of +X so that between a lens 60 and Substrates P may be filled. Thus, a control unit CONT pours a liquid 50 along the migration direction of Substrate P using the liquid feeder 1 and the liquid recovery system 2. Since the liquid 50 supplied through the supply nozzle 4 in this case from the liquid feeder 1 is drawn in space 56 with migration in the direction of -X of Substrate P, is made and flows, even if the supply energy of the liquid feeder 1 is small, a liquid 50 can be easily supplied to space 56. And also when scanning Substrate P by changing the direction which pours a liquid 50 according to a scanning direction in the which direction of the direction of +X, or the direction of -X, between the apical surface 7 of a lens 60 and Substrates P can be filled with a liquid 50, and high resolution and the large depth of focus can be obtained.

[0044]

At this time, the case where surface treatment is not performed to projection optics PL and Substrate P is considered. Drawing 5 is the mimetic diagram showing the flow of the liquid 50 in the condition that surface treatment is not performed. Here, compatibility makes low a projection optics PL front face and a substrate P front face to a liquid 50.

[0045]

Drawing 5 (a) is drawing showing the condition that the substrate stage PST has stopped. A liquid 50 is supplied from the supply nozzle 4, and are collected from the recovery nozzle 5. At this time, since compatibility is low, the contact angle theta of a liquid 50 and Substrate P is large. Drawing 5 (b) is drawing showing the condition that Substrate P started migration to X shaft orientations by the substrate stage PST. A liquid 50 is pulled by the substrate P which moves, is made and deforms. Since compatibility is low, a liquid 50 and Substrate P tend to separate a liquid 50 from the front face of Substrate P. Drawing 5 (c) is drawing showing the condition that the passing speed of the substrate P on the substrate stage PST rose further. The exfoliation field (air bubbles) H1 is formed between Substrate P and a liquid 50, and, moreover, the exfoliation field H2 is formed also between an optical element 60 and a liquid 50. If these exfoliation fields H1 and H2 are formed on the optical path of the exposure light EL, the pattern of Mask M will not be correctly imprinted by Substrate P.

[0046]

Drawing 6 is the mimetic diagram showing the flow of the liquid 50 in the condition that surface treatment of the point 7 and substrate P front face of projection optics P is carried out, as explained using drawing 4 .

[0047]

Drawing 6 (a) is drawing showing the condition that the substrate stage PST has stopped. Since surface treatment was performed and the compatibility of a liquid 50 and Substrate P was raised, the contact angle theta is small. Drawing 6 (b) is drawing showing the condition that Substrate P started migration to X shaft orientations by the substrate stage PST. Since the compatibility of a liquid 50 and Substrate P is high, even if Substrate P moves, a liquid 50 is not superfluously pulled by Substrate P. Moreover, since the compatibility over the liquid 50 of the 1st surface field AR 1 of projection optics PL is also high, the 1st surface field AR 1 and a liquid 50 do not exfoliate. Since the circumference of the 1st surface field AR 1 is surrounded in the 2nd surface field AR 2 where the compatibility over a liquid 50 is low at this time, without flowing out outside, it is stabilized to space 56 and the liquid 50 of space 56 is arranged in it. Drawing 6 (c) is drawing showing the condition that the passing speed of the substrate P on the substrate stage PST rose further. Even if it goes up the passing speed of Substrate P, since surface treatment is performed to projection optics PL and Substrate P, exfoliation is not produced between a liquid 50, and projection optics PL and Substrate P.

[0048]

As explained above, in the exposure processing based on an immersion method, inconvenient generating, such as exfoliation of a liquid 50 and generating of air bubbles, is suppressed on the point 7 of projection optics PL and the front face of Substrate P which are a part in contact with a liquid 50, and a liquid 50 can be stabilized and arranged between projection optics PL and Substrate P by performing surface treatment according to compatibility with a liquid 50 on them. Therefore, a good pattern imprint precision is

maintainable.

[0049]

In addition, it may be made to perform surface treatment according to compatibility with a liquid 50 only to one side from the point 7 of projection optics PL, and substrate P surface ******.

Moreover, in the above-mentioned operation gestalt, the inferior surface of tongue of surface 60A of an optical element 60 and Lens-barrel (attachment component) PK part was made into the 1st surface field AR 1, and it was explained that surface treatment was performed so that the compatibility over a liquid 50 may become high to this 1st surface field AR 1. That is, although it explained that the boundary of a lyophilic-ized processing field and a liquid repelling processing field was located on the lens-barrel PK inferior surface of tongue, this boundary may be set as optical element 60 front face. That is, the configuration that lyophilic-ized processing is performed to some fields (field through which exposure light passes at least) of an optical element 60, and liquid repelling processing is performed to the remaining fields may be used. Of course, the boundary of a lyophilic-ized processing field and a liquid repelling processing field may be made in agreement with the boundary of an optical element 60 and Lens-barrel PK. That is, the configuration of performing lyophilic-ized processing only to an optical element 60 may be used. Furthermore, the above-mentioned boundary may lyophilic--ization-process inferior-surface-of-tongue 7A all of not only setting it as inferior-surface-of-tongue 7A of projection optics PL but the projection optics PL.

[0050]

Furthermore, in case surface treatment is performed, it is also possible to give distribution to lyophilic (liquid repellance). If it puts in another way, surface treatment can be performed so that the contact angle of the liquid about two or more fields on the field which carries out surface treatment may serve as a value different, respectively. Or a lyophilic-ized field and a liquid repelling field are divided suitably, and you may make it arrange them.

[0051]

Moreover, the thin film for surface treatment may be monolayer, and may be film which consists of two or more layers. Moreover, the ingredient of arbitration can be used if the formation ingredient is also ingredients which can demonstrate the desired engine performance, such as a metal, metallic compounds, and the organic substance.

[0052]

Moreover, although thin film formation, plasma treatment, etc. are effective in the surface treatment of an optical element 60 or Substrate P, about the surface treatment of the lens-barrel PK which is a metal member, the compatibility over a liquid can be adjusted with physical means, such as carrying out surface roughening of the front face of this lens-barrel PK, for example.

[0053]

In addition, although it set in the above-mentioned operation gestalt, the maintenance by which the liquid between projection optics PL and Substrate P was stabilized was thought as important and the substrate P front face is made lyophilic (lyophilic processing), when thinking the recovery and removal of a liquid from a substrate P front face as important, liquid repelling (liquid-repellency treatment) of the substrate P front face may be carried out.

Moreover, although it is made to perform surface treatment according to compatibility with a liquid 50 to the point 7 of projection optics PL, and the front face of Substrate P, you may make it supply the liquid according to one [the point 7 of projection optics PL, and / at least] compatibility of a substrate P front face from the liquid feeder 1 in an above-mentioned operation gestalt.

[0054]

As mentioned above, the liquid 50 in this operation gestalt is constituted by pure water. Pure water has an advantage without the bad influence to a photoresist, an optical element (lens), etc. on Substrate P while being able to come to hand in large quantities easily by a semi-conductor plant etc. Moreover, since the content of an impurity is very low, pure water can also expect the operation which washes the front face of Substrate P, and the front face of an optical element established in the apical surface of projection optics PL, while not having a bad influence to an environment.

[0055]

And when the refractive index n of the pure water(water) to the exposure light EL whose wavelength is about 193nm is called about 1.44 to about 1.47 and ArF excimer laser light (wavelength of 193nm) is used as the light source of the exposure light EL, on Substrate P, it is short-wavelength-ized by 1/about n, i.e., 131-134nm, and high resolution is obtained. Furthermore, when what is necessary is just to be able to secure the depth of focus comparable as the case where it is used in air since the depth of focus is expanded [be /

it / under / air / comparing] to about about n times, i.e., 1.44 to 1.47 times, it can make the numerical aperture of projection optics PL increase more, and its resolution improves also at this point.
[0056]
Although the plane-parallel plate is attached at the tip of projection optics PL as an optical element 60 with this operation gestalt, even if it is the optical plate used for the optical property of projection optics PL, for example, adjustment of aberration (spherical aberration, comatic aberration, etc.), as an optical element attached at the tip of projection optics PL, it may give up, and you may be a lens. On the other hand, the optical element in contact with a liquid 50 by considering as a plane-parallel plate cheaper than a lens Even if the matter (for example, silicon system organic substance etc.) to which the permeability of projection optics PL, the illuminance of the exposure light EL on Substrate P, and the homogeneity of illumination distribution are reduced in the time of conveyance of Aligner EX, assembly, and adjustment etc. adheres to the plane-parallel plate There is an advantage that the exchange cost becomes low compared with the case where the optical element in contact with a liquid 50 is used as a lens that what is necessary is just to exchange the plane-parallel plate just before supplying a liquid 50. Namely, although it is necessary to exchange the optical element periodically since the front face of the optical element which originates in adhesion of the impurity in the scattering particle generated from a resist by the exposure of the exposure light EL or a liquid 50 etc., and contacts a liquid 50 becomes dirty By using this optical element as a cheap plane-parallel plate, compared with a lens, the cost of a substitute part can be low, and can shorten time amount which exchange takes, and the rise of a maintenance cost (running cost) and the fall of a throughput can be suppressed.
[0057]
Moreover, when the pressure between the optical elements at the tip of projection optics PL and Substrates P which are produced by the flow of a liquid 50 is large, the optical element may not be made exchangeable, but you may fix strongly so that an optical element may not move with the pressure.
[0058]
In addition, although the liquid 50 of this operation gestalt is water, since this F2 laser beam does not penetrate water when the light source of for example, the exposure light EL which may be liquids other than water is F2 laser, you may be the fault fluorine system oil [for example,] (liquid of fluorine system), and polyether fluoride (PFPE) which can penetrate F2 laser beam as a liquid 50. In this case, it lyophilic-- ization-processes by forming a thin film in the part in contact with the liquid 50 of projection optics PL, or a substrate P front face by the matter of the polar small molecular structure containing a fluorine. Moreover, if it considers as a liquid 50, there is permeability over the exposure light EL, a refractive index is high as much as possible, and it is also possible to use a stable thing (for example, cedar oil) to the photoresist applied to projection optics PL and a substrate P front face. Also in this case, surface treatment is performed according to the polarity of the liquid 50 to be used.
[0059]
Next, it explains, referring to drawing 7 about the 2nd operation gestalt of this invention.
[0060]
It is conditional expression when coefficient of viscosity of rho and a liquid 50 is set [the rate of the flow of the liquid / thickness / (here, it is spacing of projection optics PL and Substrate P) / of the liquid 50 between inferior-surface-of-tongue 7A of projection optics PL, and a substrate P front face / 50 between d, projection optics PL, and Substrate P] to mu for the consistency of v and a liquid 50 in the aligner EX of this operation gestalt.
(V-d-rho) /mu<=2000 -- (3)
It is set up so that it may be satisfied. Thereby, in space 56, a liquid 50 serves as a laminar flow and flows. In addition, although it is also considered that the rate v of two or more flow which is different according to the location in the liquid in a liquid 50 exists, the maximum velocity Vmax should just fill the above-mentioned (3) formula.
[0061]
A control unit CONT adjusts either at least among the amount of supply per unit time amount of the liquid to the space 56 by the liquid feeder 1, and the amount of recovery per unit time amount of the liquid of the space 56 by the liquid recovery system 2 so that the above-mentioned conditional expression (3) may be satisfied. The rate v of the liquid 50 which flows space 56 is determined by this, and conditional expression (3) can be satisfied. By satisfying conditional expression (3), a liquid 50 serves as a laminar flow and flows space 56.
[0062]

Or a control device CONT can satisfy conditional expression (3) also by adjusting the passing speed to the scanning direction of Substrate P through the substrate stage PST. That is, the rate v of the liquid 50 which flows space 56 may be determined with the passing speed of Substrate P. That is, by migration of Substrate P, the liquid 50 on Substrate P is dragged by Substrate P, and may make and flow. In that case, it can be satisfied with adjusting the passing speed of Substrate P of conditional expression (3). For example, what is necessary is just to make it satisfy conditional expression (3) for the passing speed of Substrate P as a rate v of a liquid 50, when Substrate P and a liquid 50 flow to projection optics PL at the almost same rate. Also in this case, a liquid 50 serves as a laminar flow and flows space 56. Moreover, in that case, during exposure of Substrate P, the liquid feeder 1 and the liquid recovery system 2 cannot not necessarily be operated, and flow of a liquid 50 can be laminar-flow-ized only by adjustment of the passing speed of Substrate P.
[0063]
In addition, in order to satisfy the above-mentioned conditional expression (3), thickness (namely, distance between projection optics PL and Substrate P) d of a liquid 50 is beforehand set up as a design value of an aligner, a rate v may be determined based on this, a rate v is beforehand set up as a design value, and you may make it determine thickness (distance) d based on this.
[0064]
Moreover, in order for a liquid 50 to serve as a laminar flow and to make it flow in space 56, as shown in drawing 8 (a), a slit can be prepared in opening of the supply nozzle 4 linked to the liquid feeder 1, or as shown in drawing 8 (b), by preparing a porous body in opening of the supply nozzle 4, a liquid 50 is rectified and it can pass in the state of a laminar flow.
[0065]
And when a liquid 50 serves as a laminar flow and flows, un-arranging [which it is called the refractive-index change and vibration by fluctuation of a pressure] is controlled, and a good pattern imprint precision can be maintained. Furthermore, by setting up and carrying out exposure processing of the aligner EX so that the above-mentioned conditional expression (3) may be satisfied while performing surface treatment to the part and substrate P front face which contact a liquid 50 among projection optics PL, the liquid 50 of space 56 is set as a much more good condition rather than affect and there is nothing for pattern imprint precision.
[0066]
In an above-mentioned operation gestalt, although the aligner which fills between projection optics PL and Substrates P with a liquid locally is adopted, this invention is applicable also to the immersion aligner to which the stage holding the substrate for exposure is moved in a cistern, and the immersion aligner which forms the liquid tub of the predetermined depth on a stage, and holds a substrate in it. About the structure of an immersion aligner and exposure actuation which form the liquid tub of the predetermined depth on a stage, and hold a substrate in it, for example to JP,6-124873,A about the structure of the immersion aligner to which the stage holding the substrate for exposure is moved in a cistern, and exposure actuation, it is indicated by JP,10-303114,A and U.S. Pat. No. 5,825,043, respectively, for example.
[0067]
In addition, although supply and recovery of a liquid 50 were continued also during exposure of said substrate P with the liquid feeder 1 and the liquid recovery system 2, you may make it suspend the supply and recovery of a liquid 50 by the liquid feeder 1 and the liquid recovery system 2 during exposure of Substrate P in the above-mentioned operation gestalt. That is, before exposure initiation of Substrate P, between the point 7 of projection optics PL, and Substrate P, the little liquid 50 is supplied on Substrate P by the liquid feeder 1, and the point 7 and Substrate P of projection optics PL are stuck to extent which can do the immersion part of the thickness below the working distance of projection optics PL (about 0.5-1.0mm), or extent by which thin liquid membrane is made on all over Substrate P through the liquid 50. Since the point 7 of projection optics PL and spacing with Substrate P are several mm or less, even if it moves Substrate P during exposure of Substrate P, without performing the supply and recovery of a liquid by the liquid feeder 1 and the liquid recovery system 2, holding 50 for a liquid with the surface tension of a liquid 50 can be continued between projection optics PL and Substrate P. Moreover, the resist on Substrate P (film) does not hurt by liquid supply from the liquid feeder 1. In this case, if coating (it is a water-repellent coat when a liquid is water) which crawls a liquid 50 by predetermined width of face to the periphery of Substrate P is performed, it can prevent a liquid 50 flowing out of on Substrate P. In addition, when moving Substrate P, it cannot be overemphasized that it is made not to make a liquid 50 generate a turbulent flow as above-mentioned conditional expression (3) is filled.
[0068]

Moreover, with an above-mentioned operation gestalt, although the liquid (50) was supplied on the substrate stage PST, before Substrate P is carried in on the substrate stage PST, a liquid may be supplied on Substrate P. In this case, carrying in on the substrate stage PST and taking out from the substrate stage PST can be performed, carrying a liquid on Substrate P with surface tension, when setting to about 0.5-1.0mm thickness of the liquid supplied all over the part on Substrate P. Moreover, if **** coating of predetermined width of face is performed to the periphery of Substrate P also in this case, the holding power of the liquid on Substrate P can be heightened. Thus, the device in which supply and recovery of a liquid are performed on the substrate stage PST can be excluded by taking out the substrate P from carrying in of the substrate P to the substrate stage PST, and the substrate stage PST, holding a liquid on Substrate P.

[0069]

In addition, with the above-mentioned operation gestalt, although it is the configuration currently filled with the liquid 50 between projection optics PL and a substrate P front face, as it is shown in drawing 9 , for example, you may be the configuration of filling a liquid 50 where the cover glass 65 which consists of a plane-parallel plate is attached in the front face of Substrate P. Here, the space 57 which cover glass 65 is supported on Z stage 51 through the supporter material 66, and is formed by cover glass 65, the supporter material 66, and Z stage 51 is an abbreviation closed space. And the liquid 50 and Substrate P are arranged to this space 57 interior. Cover glass 65 is constituted by the ingredient which has permeability to the exposure light EL. And when the supply and recovery of a liquid 50 by the liquid feeder 1 and the liquid recovery system 2 are performed and spacing is set to d for the front face of cover glass 65, and the point 7 of projection optics PL to space 56' between the front face of cover glass 65, and projection optics PL, it is set up so that the above-mentioned conditional expression (3) may be satisfied in space 56'.

[0070]

And surface treatment according to compatibility with a liquid 50 can be performed also to the front face (top face) of this cover glass 65. Since being lyophilic--ization-processed is desirable as for the front face of cover glass 65, when a liquid 50 is water, a thin film is formed in the front face of cover glass 65 by the matter of the polar large molecular structure.

[0071]

In addition, as a substrate P of each above-mentioned operation gestalt, not only the semi-conductor wafer for semiconductor device manufacture but the glass substrate for display devices, the mask used with the ceramic wafer for the thin film magnetic heads or an aligner or the original edition (synthetic quartz, silicon wafer) of a reticle, etc. is applied.

[0072]

It is applicable also to the projection aligner (stepper) of the step-and-repeat method which one-shot exposure of the pattern of Mask M is carried out [method] in the condition of having stood still Mask M and Substrate P other than the scanning aligner (scanning stepper) of step - which carries out the synchronized drive of Mask M and the substrate P, and carries out scan exposure of the pattern of Mask M as an aligner EX, and - scanning method, and carries out step migration of the substrate P one by one. Moreover, this invention can apply at least two patterns also to the aligner of step - imprinted in piles partially and - SUTITCHI method on Substrate P.

[0073]

Moreover, this invention is applicable also to the aligner of a twin stage mold. The structure of the aligner of a twin stage mold and exposure actuation are indicated by JP,10-163099,A and JP,10-214783,A (a correspondence U.S. Pat. No. 6,341,007 number, No. 6,400,441, No. 6,549,269, and No. 6,590,634), the ** table No. (correspondence U.S. Pat. No. 5,969,441 number) 505958 [2000 to], or the U.S. Pat. No. 6,208,407 number.

[0074]

As a class of aligner EX, it is not restricted to the aligner for semiconductor device manufacture which exposes a semiconductor device pattern to Substrate P, but can apply to the aligner for manufacturing an aligner, the thin film magnetic head, an image sensor (CCD), a reticle or a mask for the object for liquid crystal display component manufacture, or display manufacture, etc. widely.

[0075]

When using a linear motor for the substrate stage PST and a mask stage MST, whichever of the magnetic levitation mold using the air surfacing mold and the Lorentz force, or the reactance force which air bearing was used may be used. Moreover, the type which moves along with a guide is sufficient as each stages PST and MST, and they may be guide loess types which do not prepare a guide. The example which used the linear motor for the stage is indicated by U.S. Pat. No. 5,623,853 and 5,528,118.

[0076]
The flat-surface motor which the magnet unit which has arranged the magnet to two dimensions, and the armature unit which has arranged the coil to two dimensions are made to counter as a drive of each stages PST and MST, and drives each stages PST and MST according to electromagnetic force may be used. In this case, what is necessary is to connect either of a magnet unit and an armature unit to Stages PST and MST, and just to establish another side of a magnet unit and an armature unit in the migration side side of Stages PST and MST.
[0077]
The reaction force generated by migration of the substrate stage PST may be mechanically missed to the floor (earth) using a frame member so that it may not get across to projection optics PL. The art of this reaction force is indicated by JP,8-166475,A (U.S. Pat. No. 5,528,118) at the detail.
[0078]
The reaction force generated by migration of a mask stage MST may be mechanically missed to the floor (earth) using a frame member so that it may not get across to projection optics PL. The art of this reaction force is indicated by JP,8-330224,A (U.S. Pat. No. 5,874,820) at the detail.
[0079]
as mentioned above, the aligner EX of this application operation gestalt -- this application -- it is manufactured by assembling the various subsystems containing each component mentioned to the claim so that a predetermined mechanical precision, electric precision, and optical precision may be maintained. In order to secure these various precision, before and after this assembly, adjustment for attaining electric precision is performed about the adjustment for attaining mechanical precision about the adjustment for attaining optical precision about various optical system, and various mechanical systems, and various electric systems. Like the assembler from various subsystems to an aligner, the mechanical connections between [various] subsystems, wiring connection of an electrical circuit, piping connection of an atmospheric-pressure circuit, etc. are included. It cannot be overemphasized that it is in the front like the assembler from these various subsystems to an aligner like the assembler of each subsystem each. If it ends like the assembler to the aligner of various subsystems, comprehensive adjustment will be performed and the various precision as the whole aligner will be secured. In addition, as for manufacture of an aligner, it is desirable to carry out in the clean room where temperature, an air cleanliness class, etc. were managed.
[0080]
As micro devices, such as a semiconductor device, are shown in drawing 10 With the aligner EX of step 201 which performs the function and engine-performance design of a micro device, step 202 which manufactures the mask (reticle) based on this design step, step 203 which manufactures the substrate which is the base material of a device, and the operation gestalt mentioned above It is manufactured through the exposure processing step 204 which exposes the pattern of a mask to a substrate, the device assembly step (a dicing process, a bonding process, and a package process are included) 205, and inspection step 206 grade. In addition, in the exposure processing step 204, in order to adjust the hydrophilic property of a substrate and a liquid before exposure, the step which performs surface treatment of a substrate is included.
[Brief Description of the Drawings]
[0081]
[Drawing 1] It is the outline block diagram showing 1 operation gestalt of the aligner of this invention.
[Drawing 2] It is drawing showing the example of arrangement of a supply nozzle and a recovery nozzle.
[Drawing 3] It is drawing showing the example of arrangement of a supply nozzle and a recovery nozzle.
[Drawing 4] It is a mimetic diagram for explaining the field where surface treatment of projection optics and the substrate is carried out.
[Drawing 5] It is a mimetic diagram for explaining signs that a liquid flows between the projection optics and the substrates with which surface treatment is not performed.
[Drawing 6] It is a mimetic diagram for explaining signs that a liquid flows between the projection optics and the substrates with which surface treatment was performed.
[Drawing 7] It is drawing for explaining other operation gestalten of this invention.
[Drawing 8] It is drawing showing other examples of a supply nozzle.
[Drawing 9] It is drawing showing the cover glass formed on the substrate.
[Drawing 10] It is the flow chart Fig. showing an example of the production process of a semiconductor device.
[Description of Notations]
[0082]

1 [-- A liquid, 60 / -- An optical element, 65 / -- Cover glass,] -- A liquid feeder (an immersion means, supply means), 2 -- A liquid recovery system (an immersion means, recovery means), 7 -- A projection optics point, 50
AR1 -- The 1st surface field AR [-- Substrate,]2 -- The 2nd surface field, EX -- An aligner, P
PK -- A lens-barrel (attachment component), PL -- Projection optics

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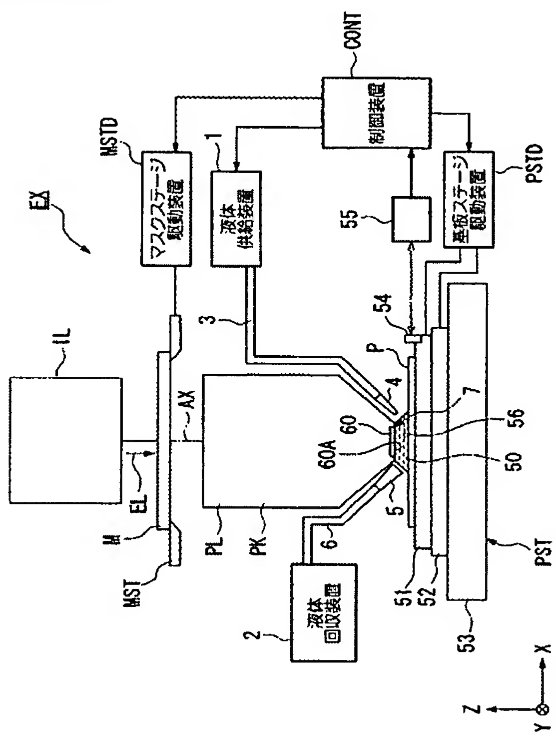
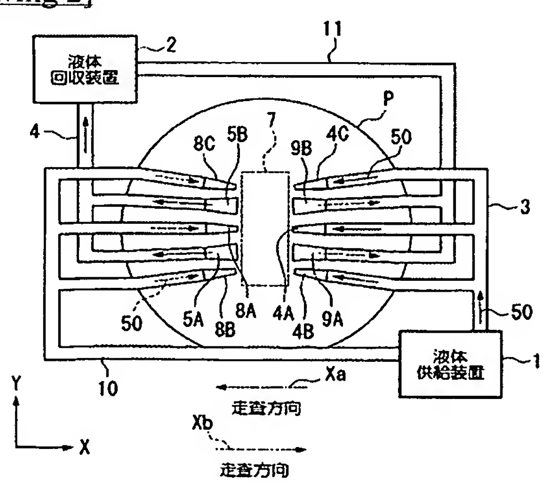
[Translation done.]

DRAWINGS

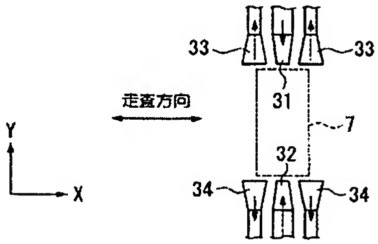
[Drawing 1]



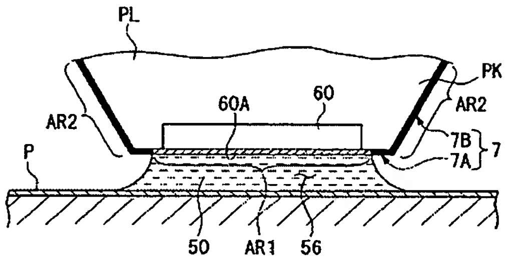
[Drawing 2]



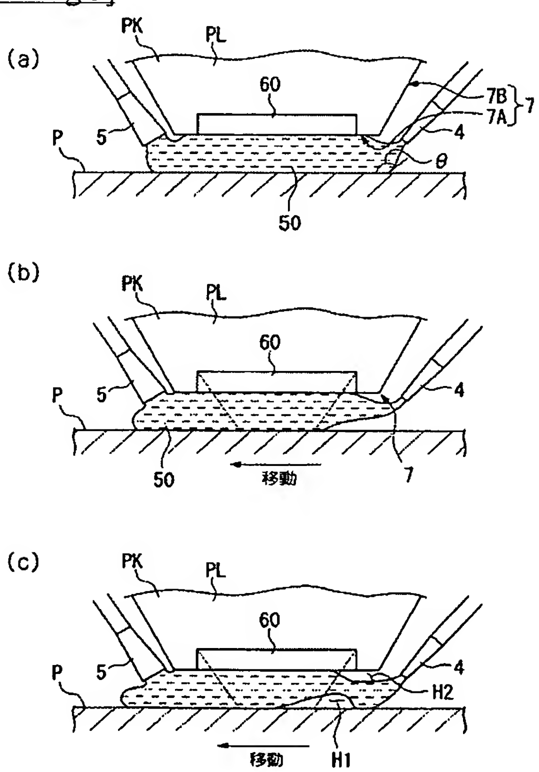
[Drawing 3]



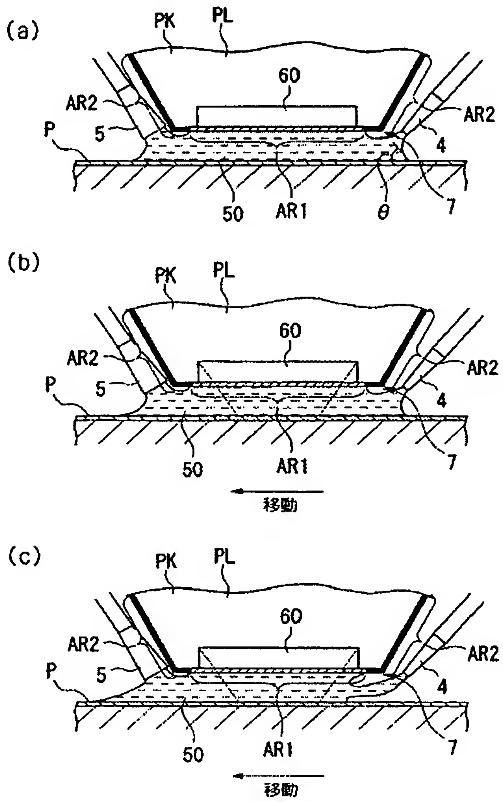
[Drawing 4]



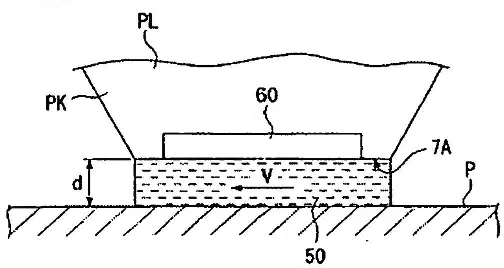
[Drawing 5]



[Drawing 6]

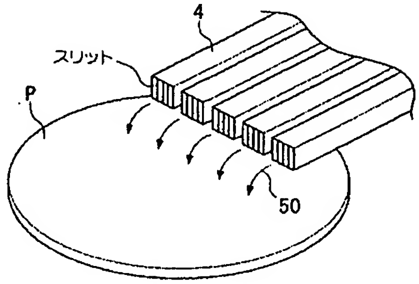


[Drawing 7]

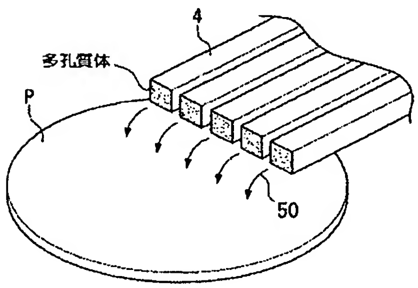


[Drawing 8]

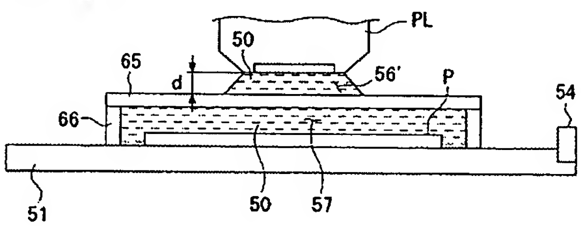
(a)



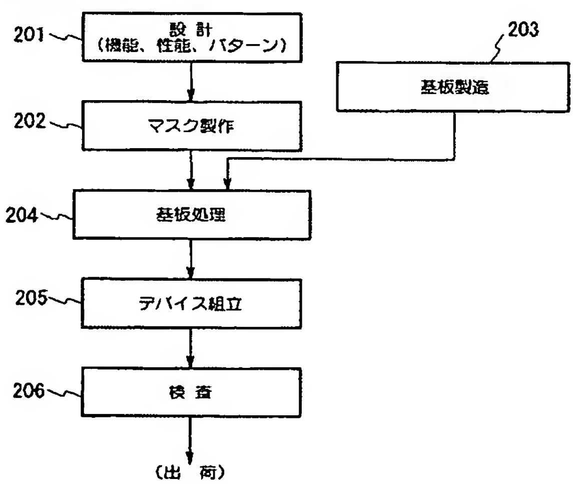
(b)



[Drawing 9]



[Drawing 10]



[Translation done.]